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APR-MAY2022

B. E. (Sixth Semester) Examination 2020

(New Scheme)

(Et & T Engg. Br.)

# DIGITAL SIGNAL PROCESSING

Time Allowed: Three hours

Maximum Marks: 80

Minimum Pass Marks: 28

Note: Attempt all questions. Part (a) of each question is compulsory. Attempt any two parts from (b), (c) and (d) of each question.

## Unit - I

1. (a) Name any two properties of DFT.

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- (b) Compute circular periodic convolution of the two

- sequences
- $x_1(n) = \{1, 1, 2, 2\}$  and

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- $x_2(n) = \{1, 2, 3, 4\}.$
- (c) Derive the DFT of the sample data sequence  $x(n) = \{1, 1, 2, 2, 3, 3\}$  and compute the corresponding amplitude and phase spectrum.
- (d) Given  $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ , find X(n) using DIT-FFT algorithm.

## Unit - II

- 2. (a) Define Canonic and non-canonic structure. 2
  - (b) Determine the direct form I and II realisation for a third order IIR transfer function:

$$H(z) = \frac{0.28z^2 + 0.319z + 0.04}{0.5z^3 + 0.3z^2 + 0.17z - 0.2}$$

(c) Determine the parallel realisation of the IIR digital filter transfer functions:

$$H(z) = \frac{3(2z^2 + 5z + 4)}{(2z+1)(z+2)}$$

(d) Develop cascade realisation structure for:

$$H(z) = \frac{\frac{2}{6} + \frac{5}{24} + \frac{5}{24}z^{-1} + \frac{1}{24}z^{-2}}{1 - \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}}$$

#### **Unit - III**

- 3. (a) Define phase delay and group delay.
  - (b) Write short notes on Window Techniques by clearly illustration of the spectrum.
  - (c) A low pass filter is to be designed with the following derived frequency response:

$$H_d(e^{jw}) = \begin{cases} e^{-j2w}, & -\pi/4 \le w \le \pi/4 \\ 0, & \pi/4 < |w| \le \pi \end{cases}$$

Determine the filter coefficient  $h_d(n)$  if the window function is defined as:

$$w(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0, & \text{otherwise} \end{cases}$$

Also, determine the frequency response  $H(e^{iw})$  of the designed filter.

$$H_d^{(e^{nv})} = \begin{cases} e^{-j3w}, & -3\pi/4 \le w \le 3\pi/4 \\ 0, & 3\pi/4 < |w| \le \pi \end{cases}$$

Determine  $H(e^{jw})$  for M = 7 using a Hamming window.

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## Unit - IV

- 4. (a) What are the requirements for converting a stable analog filter into a stable digital filter?
  - (b) Convert the analog filter into a digital filter whose system function is:

$$H(\overline{s}) = \frac{s+0\cdot 2}{\left(s+0\cdot 2\right)^2+9}$$

Use the impulse invariant technique, assume T = 1 s.

(c) Determine H(z) for a Butterworth filter satisfying the following constraints:

$$\sqrt{0.5} \le |H(e^{jw})| \le 1 \qquad 0 \le w \le \pi/2$$
$$|H(e^{jw})| \le 0.2 \qquad 3\pi/4 \le w \le \pi$$

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with T=1s. Apply impulse invariant transformation. 7

(d) Design a digital Chebyshev filter to satisfy the constraints:

$$0.707 \le |H(e^{jw})| \le 1, \quad 0 \le w \le 0.2\pi$$
$$|H(e^{jw})| \le 0.1, \quad 0.5\pi \le w \le \pi$$

using bilinear transformation and assuming T = 1 s.

#### Unit - V

- 5. (a) List the advantages of multirate signal processing. 2
  - (b) Obtain the expression for the output y(n) in terms of x(n) for the multirate system given as follow: 7

$$x(n) \rightarrow \boxed{\uparrow 5} \rightarrow \boxed{\downarrow 20} \rightarrow \boxed{\uparrow 4} \rightarrow y(n)$$

(c) Implement a two-stage decimator for the following specifications.

Sampling rate of the input signal = 20,000 HzM = 100

Passband = 0 to 40 Hz.

Transition band = 40 to 50 Hz

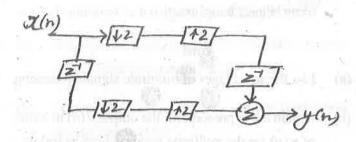
Passband ripple = 0.01

Stop band ripple = 0.002

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(d) For the given system with input x(n), find the output y(n).

 $x(n) = \dots x_{-4} x_{-3} x_{-2} x_{-1} x_0 x_1 x_2 x_3 x_4 \dots$ 



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Praidward = 0 to 40 Ltz

Tresmitten back = 40.16 ±0.15z